THE EFFICIENCY OF BIRDS IN DESTROYING OVERWINTERING LARVÆ OF THE EUROPEAN CORN BORER IN NEW ENGLAND.[1]

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Several years ago, not long after investigations of the European corn borer (*Pyrausta nubilalis* Hübn.) were begun by the Bureau of Entomology of the United States Department of Agriculture, it was frequently observed that cornstalks infested by the larvæ of this insect showed in the spring of the year numerous holes along the stalks, the burrows of the insect beneath these holes being empty. This was the first evidence of any appreciable feeding by birds on this insect. Such evidence of bird feeding has been found each spring and it is now possible to associate this work with the downy woodpecker (*Dryobates pubescens medianus* Swainson) a winter resident in this region. In numerous instances, this bird has been observed at close range at work on the infested standing cornstalks. Plate 1A, shows sections of cornstalks from which the larvæ of the corn borer have been removed by this bird. This type of feeding by chickadees (*Penthestes atricapillus atricapillus* Linn.) has also been observed by Mr. F. H. Mosher.

Within the last few years observations have shown another type of feeding by birds on the overwintering larvæ of this insect. This is the shredding of cornstalks illustrated in Figure 1*B*, and is the result of feeding by grackles, blackbirds, starlings and probably several other species of migrating birds. These birds arrive in the latitude of Boston, Mass., from the middle to the last of April. Such work was especially noticeable in cornstalks that had been piled in the fall or in stalks that had fallen over for one reason or another and lay on the surface of the soil. These birds have frequently been observed feeding in flocks in the spring, and in a short time they are able to gather the larvæ

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from quite a number of cornstalks. They are able also to shred infested corn stubble and take the larvæ in the more exposed positions, but apparently are not able to reach the larvæ contained in standing stalks.

In the fall of 1922, when it was apparent that the birds were becoming a really important factor in the reduction of the numbers of the corn borer, experiments were undertaken to determine how extensive such feeding was. These experiments were also carried on during the winter of 1923-1924. The object of this work was to obtain information on the extent of the combined feeding by all species of birds concerned rather than the extent of feeding of any particular species, the intention being to obtain as far as possible a picture of the present importance of birds as a group in relation to this insect rather than a study of the value of any one particular species.

The studies pursued during the fall of 1922 and the spring of 1923 may be treated under two heads; first, the extent of bird feeding on the larvæ in infested cornstalks placed in the field for this purpose; second, the extent of feeding by birds on larvæ in host plants that remained undisturbed in natural positions during the winter.

In the first part of this work twenty representative locations were selected throughout the infested area of eastern New England. In each of these locations ten stakes were set upright in the soil, there being six infested stalks fastened to each of these stakes. The three following types of corn were represented at each location: pop corn, sweet corn (Golden Bantam) and field corn (Longfellow Flint). Counts of the larval population of representative stalks during the fall gave an average figure as to the number of larvæ expected from each stalk, and from this average the number of larvæ expected from each station was computed. This series of experiments was placed in the field in November, 1922, after all larval activity had ceased, and the stalks were collected in April, 1923, before larval activity had commenced in the spring. The chance of losing an appreciable number of larvæ by migration was small, since during this period the larvæ were entirely dormant and inactive. Of these twenty experiments five showed extensive feeding by birds

when examined in the spring, mostly the work of woodpeckers. Of the remaining fifteen experiments one was destroyed by an over-anxious farmer, one was partly destroyed by a tractor and the others showed only very slight traces of feeding by birds or no evidence of bird feeding whatever. Table Number 1 shows the extent of bird feeding on the five experiments attacked, and the recovery of larvæ from stations that escaped noticeable bird feeding. The average recovery of larvæ from experiments not attacked by birds was 1,090 larvæ per station as compared with the average expectancy of 1,223.2. This apparent loss of 10.8 per cent of expected larvæ per station was undoubtedly

TABLE I

Extent of Feeding by Birds on Experimental Material in the Spring of 1923.

Experiments on which birds fed.

Location	Date placed 1922	Date recovered 1923	No. larvæ expected	No. larvæ recovered	Apparent loss	Per cent of larvæ credited to bird feeding based on average larval content of stalks	Per cent of larvæ credited to bird feeding based on average spring infestation of stalks, that escaped attack.
Scituate, Mass.	XI-3	IV-11	906	123	783	86%	84%
Newbury, Mass.	XI-10	IV-14	1289	214	1075	83%	81%
Rockport, Mass.	XI-10	IV-12	1289	209	1080	83%	81%
Medford, Mass.	X-25	IV-9	1289	390	899	69%	66%
Arlington, Mass.	XI-2	IV-9	809	576	233	27%	12%

Experiments on which birds did not feed.

Bristol, N. H.	XI-8	IV-29	1289	1397	
Framington, N.H.	XI-7	IV-29	1289	1341	
Wells, Me.	XI-7	IV-28	1289	1132	
Concord, Mass.	XI-4	IV-10	809	854	
Falmouth, Mass.	X-31	IV-7	1289	1135	
Quincy, Mass.	XI-4	IV-11	906	944	
Harwich, Mass.	XI-1	IV-6	1289	909	
Methuen, Mass.	XI-2	IV-14	1289	1014	
Manomet, Mass.	X-30	IV-6	1289	1081	
Tyngsboro, Mass.	XI 8	IV-14	1289	990	
Wareham, Mass.	XI-1	IV-8	1289	1056	
Wellfleet, Mass.	X-31	IV-7	1289	1106	
Worcester, Mass.	X-26	IV-11	1289	1222	

caused by migration of a few larvæ and the loss of small pieces of stalks containing larvæ during transportation of the cornstalks used in the experiment.

The average winter mortality in the 18 experiments listed in table No. 1 was 10.5% per cent. The average per cent of larvæ credited to bird feeding in the five stations where stalks were attacked, was 61. The average per cent of larvæ credited to bird feeding in the 18 stations recovered was 17.

The stations that showed extensive feeding by birds (Fig. 1) are all within the area most heavily infested by the European corn borer and localities where infestation has been severe for several years. Because of this fact and because no marked evidence of bird feeding was found in areas slightly infested or areas that had become heavily infested by the insect within the last year or two, it would appear that woodpeckers are aware of the fact that infested cornstalks contain desirable food only in this heavily infested area, and that in more sparsely infested regions or in areas where infestation had but recently become severe they are for the most part still unfamiliar with the existence of this source of food.

Several of the more commonly infested weeds and cultivated plants were also tied to stakes to observe possible feeding by birds on larvæ contained in such plants. These were placed with the experiment at Medford, Mass., mentioned in Table 1, where birds took 69 per cent of the larvæ from the cornstalks tied to stakes.

Of the several plants thus observed, common sunflower (*Helianthus annuus* L.), Princesplume (*Polygonum orientale* L.), *Polygonum* sp., and cocklebur (*Xanthium* spp.) showed extensive feeding by birds of the same sort attributed to woodpeckers while no evidence of such feeding was noticed in Abutilon (*Abutilon theophrasti* Medic.), pigweed (*Amaranthus retroflexus* L.), ragweed (*Ambrosia* sp.,) beggar-ticks (*Bidens* sp.), pot-marigold (*Calendula officinalis* L.), aster (*Callistephus* sp.), feather cockscomb (*Celosia argentea* L.), *Cosmos bipinnatus* Cav., *Dahlia* sp., barnyard grass (*Echinochloa crusgalli* L.), Japanese millet (*Echinochloa* sp.), Gladiolus sp., strawflower (*Helichrysum bracteatum*

Andr.), geranium (*Pelargonium hortorum*), lima bean (*Phaseolus lunatus*, L.), and African marigold (*Tagetes erecta* L.).

The field examinations of cornstalks showed much the same evidence as was obtained from the experimental work described in the preceding paragraphs. Numerous instances were found where birds had removed a high percentage of the larval content of cornstalks and such instances were found only in heavily

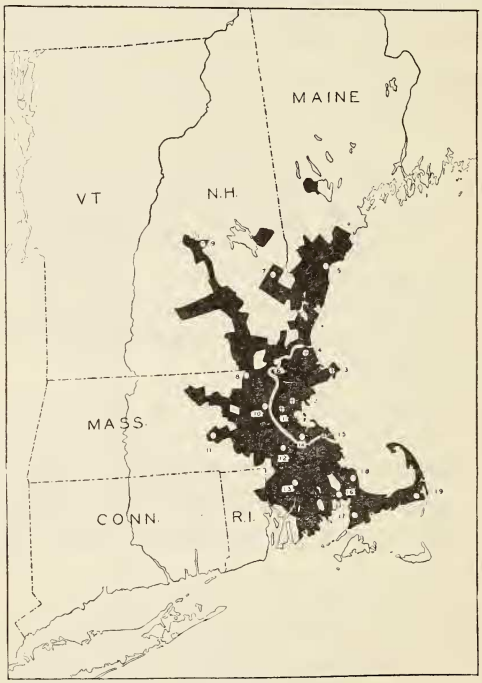

Fig. 1. Map of the area known to be infested by the European Corn Borer in New England in 1922. Circles show localities where experiments were placed in the fall of 1922; clear circles indicate that no feeding by birds was found, while circles having a cross in the center indicate localities where birds fed on larvae contained in the corn stalks of the experiment.

A white line surrounds the area known to be infested up to July 1, 1919.

1—Arlington, Mass.
2—Medford, Mass.
3—Rockport, Mass.
4—Newbury, Mass.
5—Wells, Me.
6—Methuen, Mass.
7—Farmington, N. H.
8—Tyngsboro, Mass.
9—Bristol, N. H.
10—Concord, Mass.
11—Worcester, Mass.
12—Walpole, Mass.
13—Taunton, Mass.
14—Quincy, Mass.
15—Scituate, Mass.
16—Wareham, Mass.
17—Falmouth, Mass.
18—Manomet, Mass.
19—Harwich, Mass.

infested areas and in localities that had been infested for several years. In sparsely infested localities or in areas where infestation had been severe only recently, no extensive feeding was noticed although in some cases there were traces of feeding by birds. The following table shows the condition as found in certain heavily infested fields that were found to be attacked by birds.

TABLE II.

Extent of Feeding by Birds on Material Undisturbed by Man in the Spring of 1923.

Locality	Date examined	Type of corn	Condition of cornstalks	Size of area	Estimated number of larvæ taken by birds	Estimated per cent of larvæ taken by birds
Watertown, Mass.	IV-2-23	Sweet	Standing and broken over	1½ acres	186,480	92%
Watertown, Mass.	IV-6-23	"	standing and broken over	¼ acre	26,957	78%
Milton, Mass.	IV-13-23	"	Lying on soil	1 acre	.....	30%
Marblehead, Mass.	V-3-23	"	standing and broken over	½ acre	140,946	97%
Melrose, Mass.	V-11-23	"	In piles partly burned	.....	.....	80%

The figures mentioned in this table were obtained by counting the number of cornstalks in the several fields, estimating the fall infestation of the stalks, and comparing this figure with the average infestation found on the date of the examination. The spring infestation per cornstalk was obtained by averaging several series of counts made in different parts of each field. In all these instances both types of bird feeding shown in figure 1 were found, the feeding attributed to woodpeckers being extensive in standing stalks and the stalks lying on the ground being shredded by other birds.

In weeds instances were found of the removal of considerable numbers of larvæ from cocklebur (*Xanthium* sp.) and barnyard grass (*Echinochloa crusgalli* L.). In one field several score of

dahlia plants were found from which birds had removed nearly all the larvæ of the European corn borer that these plants had harbored.

Although birds (particularly the downy woodpecker) feed to a limited extent on the larvæ of this insect in the fall and winter, most of the feeding is done in the spring, especially the shredding of stalks lying on the ground. The experiment placed in Medford, Mass., (table 1), showed on April 9, 1923, that birds had by that time taken 65 per cent of the larvæ from the cornstalks. A similar experiment in the same locality was continued until June 27, 1923, a date when most of the insects had transformed to adults. At that time examination showed that birds had apparently taken 82 per cent of the insects from the cornstalks.

In the fall of 1923 a series of experiments much similar to those previously described was placed in the field for the purpose of obtaining information on the extent of feeding by birds on this insect. However, this time fifty stations were chosen instead of twenty as in the previous work. Each station was composed of four stakes to each of which was fastened five infested cornstalks, the larval expectancy as obtained from stalk counts being on an average of 15.5 larvæ per stalk.

These stations were so selected as to cover the entire area infested by this insect in New England and were run out in lines as straight as possible from Arlington, Mass., as a center as follows: first line comprising 12 stations in a northeasterly direction as far as Sebago, Me.; second line comprising 5 stations in a northerly direction as far as Farmington, N. H.; third line comprising 8 stations in a direction north by northwest as far as Bristol, N. H.; fourth line to the northwest as far as Gardner, Mass. comprising 3 stations; fifth line comprising 4 stations to the west as far as Worcester, Mass.; sixth line to the southeast as far as Touisset, Mass., composed of 4 stations; seventh line to the south as far as Mattapoisett, Mass., composed of 4 stations; eighth line composed of 9 stations to the southeast and extending on Cape Cod as far as Provincetown, Mass. Fig. 2.

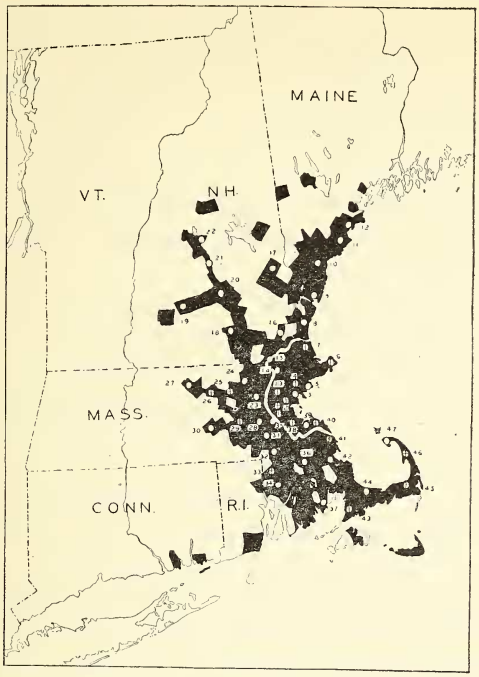

Fig. 2. Map of the area known to be infested by the European Corn Borer in New England in 1923. Circles show localities where experiments were placed in the fall of 1923;—clear circles indicate that no feeding by birds was found, while circles having a cross in the center indicate localities where birds fed on larvae contained in the corn stalks of the experiment. A white line surrounds the area known to be infested up to July 1, 1919.

1—Arlington, Mass.
2—Medford, Mass.
3—Saugus, Mass.
4—Beverly, Mass.
5—Marblehead, Mass.
6—Rockport, Mass.
7—Newbury, Mass.
8—Hampton, N. H.
9—Kittery, Me.
10—Wells, Me.
11—Biddeford, Me.
12—Scarboro, Me.
13—Woburn, Mass.
14—Andover, Mass.
15—Methuen, Mass.
16—Kingston, N. H.
17—Farmington, N. H.
18—Bedford, N. H.
19—Hillsboro, N. H.
20—Concord, N. H.
21—Franklin, N. H.
22—Bristol, N. H.
23—Concord, Mass.
24—Westford, Mass.
25—Harvard, Mass.
26—Leominster, Mass.
27—Gardiner, Mass.
28—Natick, Mass.
29—Southboro, Mass.
30—Worcester, Mass.
31—Medfield, Mass.
32—Foxboro, Mass.
33—Attleboro, Mass.
34—Touisset, Mass.
35—Needham, Mass.
36—Bridgewater, Mass.
37—Mattapoisett, Mass.
38—Milton, Mass.
39—W. Hingham, Mass.
40—Cohasset, Mass.
41—Marshfield, Mass.
42—Kingston, Mass.
43—Falmouth, Mass.
44—Sandwich, Mass.
45—Brewster, Mass.
46—Wellfleet, Mass.
47—Provincetown, Mass.

Examinations of the cornstalks of these experiments in the spring of 1924 showed that 16 of these stations exhibited feeding by birds to a noticeable extent, while the remainder showed either a mere trace of bird feeding or no evidence of such feeding at all. In Table 3 those stations that showed bird feeding are listed together with the number and percentage of larvæ apparently removed from the stalks by birds.

The average winter mortality for the 38 stations listed in table no. 3 was 4 per cent.

The average per cent of larvæ apparently taken by birds in the 16 stations that showed bird feeding (based on the average recovery per stalk in experiments not touched by birds) was 54.

The average per cent of larvæ apparently taken by birds in the total number of 47 experiments (based on the average recovery per stalk in experiments not touched by birds) was 19.

Three stations were lost or destroyed, leaving 31 that showed either a mere trace of bird feeding or none at all. The infestation in the fall was on an average 310 larvæ per station. Spring examinations of the 31 stations that showed no important feeding by birds proved that the average infestation at that time was 14.7 larvæ per stalk or 294 larvæ per station, an apparent loss per station of 16 larvæ or approximately 5 per cent of the expected larvæ. This loss is slight when it is remembered that in some stations birds apparently did take a few of the larvæ, and that the cornstalks were necessarily handled several times and were transported for considerable distances, so that small pieces were sometimes broken off and lost. These figures, however, are offered to show that the findings as regards bird feeding, shown in Table no. 3, present a fair picture of the extent to which birds fed on this material.

These results show a considerable increase in the area in which birds fed extensively, (Fig. 2 and 3) over the results obtained in the spring of 1923. This may be due to the fact that the larger number of stations provided a much more accurate test of conditions and so gave a much better picture, or it may indicate a widening field over which birds have become aware of an existing food supply. There is also a possibility of the element of chance entering to the extent that if the right species of birds

found the stations, feeding would result, whereas if the experiments remained undiscovered by birds able to take larvæ from the cornstalks no evidence of feeding would be found. Whatever the reason, however, the fact of evidence of bird feeding on overwintering larvæ of this insect in cornstalks over a much more extended area during the spring of 1924 than was observed previously remains, and it is the writer's belief that birds were a more important factor in reducing the numbers of the European corn borer in the spring of 1923 than in a corresponding period in 1922, and that in the spring of 1924 they were of greater importance than in the same period in 1923; in other words, that the importance of birds as a means of natural control has been increasing each spring for the last three years.

The figures showing the percentage of larvæ taken by birds as shown in Table 3 represent the feeding up to the time that the experimental material was collected in the spring and so do not show the total amount of feeding that birds might have done had the material remained in the field a few weeks longer. As already mentioned, this same condition prevailed in the consideration of the experiments examined in the spring of 1923. It was necessary, however, to collect these experiments early in April because of a desire to examine the cornstalks before the larvæ had moved from the exact locations in the stalks in which they rested at the time the material was set out the previous fall.

It is probable also that birds were unable to remove some of the larvæ from the staked experiments because in tying cornstalks to the stakes that part of the stalks lying next to the stakes was rendered inaccessible to the birds.

In the series of experiments examined in the spring of 1924, several of the experiments that showed no feeding by birds were located in areas that had been heavily infested by the insect for several years. Noticeable among those was the experiment located in Saugus, Mass. (table 3). This experiment was placed on a farm where corn had been severely infested each year since 1919. In this instance, however, little corn was grown in 1923 because of the heavy infestation previously experienced. A second instance of this condition was found in Marblehead,

TABLE NO. 3.

Extent of Feeding by Birds on Experimental Material in the Spring of 1924.

Experiments on which birds fed.

Locality	Date Placed 1923	Date Examined 1924	Total larval expectancy	Number of larvae recovered	Apparent number of larvae taken by birds	Per cent of larvae taken by birds[1]	Per cent of larvae taken by birds.[2]
Arlington, Mass.	11–14	4–13	310	125	185	59.6	57.4
Attleboro, Mass.	11–28	4–11	310	81	229	73.8	72.4
Beverly, Mass.	11–14	4–11	310	203	102	32.9	29.2
Brewster, Mass.	11–24	4–14	310	81	229	73.8	72.4
Cohasset, Mass.	11–20	4–11	310	201	109	35.1	31.6
Falmouth, Mass.	11–23	4–12	310	118	192	61.9	59.8
Harvard, Mass.	11–23	4–12	310	241	69	22.2	19.
Leominster, Mass.	11.23	4–10	310	105	205	66.1	64.2
Marshfield, Mass.	11–20	4–12	310	203	102	32.7	29.2
Medford, Mass.	11–3	4–25	310	99	211	68.	66.3
Milton, Mass.	11–23	4–12	310	131	179	57.7	55.4
Newbury, Mass.	11–14	4–11	310	62	248	80.	78.5
Rockport, Mass.	11–14	4–10	310	119	201	64.8	59.5
Southboro, Mass.	11–27	4–10	310	77	233	75.1	73.4
Wellfleet, Mass.	11–24	4–14	217	76	141	64.9	63.1
Woburn, Mass.	11–14	4–12	310	237	73	23.5	19.3

Experiments on which birds did not feed

Andover, Mass.	11–19	4–16	310	180	
Bridgewater, Mass.	11–27	4–10	310	262	
Concord, Mass.	11–16	4–12	310	256	
Foxboro, Mass.	11–28	4–11	310	262	
Gardner, Mass.	11–29	4–20	310	357	
Hingham, Mass.	11–20	4–12	170	137	(partly destroyed)
Kingston, Mass.	11–24	4–12	310	414	
Marblehead, Mass.	11–15	4–12	310	388	
Mattapoisett, Mass.	11–27	4–10	310	387	
Medfield, Mass.	11–24	4–11	310	318	
Methuen, Mass.	11–19	4–16	310	256	
Natick, Mass.	11–23	4–10	310	346	
Needham, Mass.	11–16	4–14	310	268	
Provincetown, Mass.	11–24	4–14	310	325	
Sandwich, Mass.	11–23	4–11	310	333	
Saugus, Mass.	11–14	4–11	310	303	
Touisset, Mass.	11–28	4–10	310	228	
Worcester, Mass.	11–27	4–10	310	228	
Westford, Mass.	11–15	4–12	310	357	
Biddeford, Me.	11–22	4–14	310	328	
Kittery, Me.	11–22	4–14	310	285	
Scarboro, Me.	11–22	4–14	310	295	
Wells, Me.	11–22	4–14	310	232	
Bedford, N. H.	11–21	4–17	310	281	
Bristol, N. H.	11–22	4–16	310	228	
Concord, N. H.	11–21	4–16	263	203	(partly destroyed)
Farmington, N. H.	11–21	4–16	310	340	
Franklin, N. H.	11–21	4–16	310	181	
Hampton, N. H.	11–22	4–14	310	366	
Hillsboro, N. H.	11–21	4–16	310	200	
Kingston, N. H.	11–20	4–28	310	276	

[1] Based on the average larval contents of stalks in the fall.
[2] Based on the average larval recovery at stations not attacked by birds.

Mass., where birds did not feed on the larvæ contained in the cornstalks of the experiment (table 3) although it was found in the spring of 1923 that they had removed a high per cent of the borers from a field of heavily infested cornstalks (table 2). From these instances it appears that birds might not be depended on to feed on corn borer larvæ in cornstalks in the same locality each year. On the other hand, heavily infested localities are known, noticeably Medford, Mass., where birds have fed on overwintering larvæ consistently in the springs of 1922, 1923 and 1924.

Throughout the infested area of Massachusetts there was very little corn standing in the field during the winter of 1923-1924. The condition of all the experiments was the same, therefore, in that practically no cornstalks other than the experiments were to be found by the birds and for this reason there was no influence brought to bear, as far as the extent of feeding was concerned, by proximity of the experiments to infested cornfields. Because of the general scarcity of standing corn during the winter of 1923-1924 it might appear that a condition of concentrated feeding on the experimental material might result. It does not seem that any such phenomenon took place, however, because in the experiments examined in the spring of 1924, in no case was the bird feeding found to be as extensive as on the

TABLE NO. 4.

The Extent of Bird Feeding on Experimental Material at Medford, Mass., on different dates in the Spring of 1924.

Date Examined	Number of stalks	Number of expected larvæ	Number of larvæ recovered	Apparent number taken by birds	Apparent per cent taken by birds
IV-4-24	10	155	100	55	35.5
IV-11-24	10	155	73	82	53.
IV-17-24	10	155	62	93	60.
IV-24-24	10	155	108	47	30.3
V-2-24	10	155	50	105	67.7
V-8-24	10	155	32	123	79.3
V-15-24	10	155	18	137	88.4

stalks of several cornfields examined in the spring of 1923 and listed in table 2.

When birds feed in the spring on larvæ contained in cornstalks that were piled up the previous fall and remained in such condition through the winter, an interesting phenomenon is frequently noticed. In the spring, larvæ desert the wet cornstalks in the lower parts of such a pile, migrating to the dry stalks above where conditions for transformation are much more favorable. It is on the larvæ contained in these dry stalks on the top of the pile that birds such as grackles and blackbirds feed extensively so that as the spring advances it is frequently found that few larvæ remain in the lower stalks of the pile because of the migration of the stalks above, and a few larvæ remain in the dry stocks on the top of the pile because birds have shredded the stalks and removed a high percentage of them. This condition has been found several times experimentally, and has been noticed in several localities in the field where cornstalks have passed the winter in piles.

Observations as to the extent of feeding by birds on larvæ in cornstalks standing undisturbed in the field in the spring of 1924 were possible in only a few localities, mostly in very small lots of stalks because of a law in the state of Massachusetts compelling all persons to destroy standing corn in the fall of 1923. Those found, for the most part in small back-yard gardens, often showed evidence of extensive feeding by birds. Thus a small plot of about 1,500 hills of standing corn in Wakefield, Mass., showed that birds had removed a very high percentage of the larvæ from the stalks. In various localities stubble and stalks lying on the ground were shredded and many larvæ no doubt removed. As far as these observations were possible, they coincide with the results obtained in the experimental work already described.

The question has been asked whether birds know that infested cornstalks contain larvæ or whether the feeding that they do is more in the nature of an accident. Beside the experiment at Medford, Mass., mentioned in table 3 from which birds are credited with removing 68 per cent of the larvæ a like experiment was placed in the fall of 1923, similar in every respect

except that the cornstalks showed no trace whatever of infestation by the European corn borer. Spring examinations showed that whereas birds had fed extensively on larvæ in the infested stalks, there were only one or two shallow incisions that might be credited to birds in the stalks that were entirely free from infestation by this insect. These uninfested stalks were, therefore, probably examined by the birds but the experiment showed that they were soon undeceived as to the fact that these stalks, although so much like the nearby infested ones in appearance, contained no larvæ of the corn borer. Field observations have shown that birds also feed in the spring on the pupæ of this insect, the nature of the feeding being similar in every respect to that described in the case of their feeding on larvæ. In some cases portions of the pupæ remain in the burrows of the insect as if the birds were not entirely pleased with the change that its food supply had undergone.

These studies have been confined mostly to the feeding by birds on the larvæ of the European corn borer in the fall, winter and spring, at which time the insect is in overwintering quarters within the host plant, because no such extensive feeding has been observed during the growing season. Adults of the insect are active only at night, resting during the day on the under sides of leaves unless disturbed when their flight is short and low and is to the nearest cover from the seat of disturbance. The larvæ for the greater part of their lives feed hidden within the food plants, leaving their burrows infrequently except during the warmer nights of midsummer. It is known, however, that birds readily take the adult of the insect although observations seem to indicate that up to the present time they have not taken larvæ from growing plants in any noticeable numbers. On two occasions, during studies of the capabilities of flight of the moths, birds took the flying insects to such extent as to interfere seriously with the success of the experiments. It is probable, therefore, that the reason that they do not feed more extensively on the moths is not because of any distaste for them, but because of the inactivity of the moths during the hours of sunlight.

Since the larvæ of the European corn borer in the overwintering condition are nearly destitute of hairs and the skin is

rather thin and sparingly chitinized, they are ideal food for birds. Furthermore, at this time of the year the body of the larva is filled with so-called fat body so that the insect becomes food of the highest value with only a small portion of waste matter. The larvæ in standing stalks, during times of heavy infestation, provide a plentiful supply of food for birds, such as woodpeckers, during the winter, provided the stalks are not completely covered with snow, at a time when other food is scarce. They also provide a source of food for migrating insectivorous birds in the spring, especially those arriving early before other insects become active and available in abundance. There is, therefore, every reason to hope that birds will take advantage of this food supply to the benefit not only of themselves, but also of man. This they may readily do, provided that they are able to locate the larvæ in the stalks, as these experiments seem to indicate they are doing more and more, and if they are able to remove the larvæ from the stalks after finding them, a feat of which not all insectivorous birds will be capable. However, there is ample evidence to indicate that their industry may help to hold the insect partially in check, or even so to reduce its numbers in some localities during the winter and spring that damage by the species may not be extensive enough to cause heavy loss to crops in such localities the following summer.

Summary.

Evidence of feeding by birds on larvæ of the European corn borer has been found each spring for several years in New England. Such work was of two distinct types; the work of woodpeckers, particularly the downy woodpecker, which drills holes into standing stalks in order to reach the overwintering larvæ of this insect; and work by grackles, blackbirds, starlings and other species which shred stalks that have fallen over and devour the hiding larvæ.

For the most part such feeding by birds has been confined to localities that have been heavily infested for several years, the extent of such feeding having been found to vary greatly, but counts have shown that in some fields of sweet corn over

90 per cent of the overwintering larvæ have been removed from the stalks.

Experiments where infested cornstalks were placed in representative localities in the infested area of New England in the fall of 1922 and 1923 were examined the following spring in each case, before larvæ had become active. These experiments were for the purpose of determining whether or not the habit of feeding on larvæ of this insect was general. The experiments examined in the spring of 1923 showed that of 18 localities the cornstalks of which were recovered in good condition, birds had fed extensively on larvæ contained in the cornstalks of 5 localities, the proportion of larvæ credited to such feeding ranging from 12 percent to 84 per cent, and averaging 61 per cent for these 5 localities and 17 per cent for the whole 18 experiments. Examined in the spring of 1924 showed that of 47 localities the cornstalks of which were recovered in good condition, birds had fed extensively on the larvæ contained in the cornstalks of 16 localities, the extent of such feeding ranging from 19 percent to 78.5 per cent. The average proportion of larvæ taken from these 16 localities was 54 per cent and the average of larvæ taken from the whole number of 47 localities was 19 per cent. The feeding, which was mostly the work of woodpeckers, was found to be over a much more extended area in the spring of 1924 than in the spring of 1923.

Feeding by woodpeckers on the larvæ of this insect overwintering in sunflower, (*Helianthus annuus* L.), Princesplume (*Polygonum orientale* L.), *Polygonum* sp., and cocklebur (*Xanthium* spp.) have also been found in experiments and in barnyard grass (*Echinochloa crusgalli* L.) and cocklebur (*Xanthium* spp.) in the field.

The importance of the feeding by birds on overwintering larvæ of this insect at the present time, taking the infested area in New England as a whole, is not great, but in small areas the importance of their feeding must be considerable, since these small areas are often very heavily infested. The important point at present is that birds are finding the overwintering larvæ of the corn borer, that they are feeding on them, and that such feeding seems to be on the increase.

Explanation of Plate I.

At left. The appearance of corn stalks after woodpeckers have fed on the larvæ of the European corn borer that the stalks harbored. The section to the right shows the holes made by these birds in reaching the larvæ. The two sections to the left are of one corn stalk split open to show the condition of the center of the stalk, all the larvæ having been removed by these birds.

At right. Corn stalks infested by the European corn borer showing the appearance of the stalks after birds such as blackbirds and grackles have broken them open and devoured the larvæ that they contained.